Vol. XI JUNE, 1924 No. 6

JOURNAL
OF THE
BOSTON SOCIETY
OF
CIVIL ENGINEERS

Published monthly, excepting July and August, by the Society,
715 Tremont Temple, Boston, Massachusetts.

Entered as second-class matter, January 15, 1914, at the Post Office at Boston, Mass., under Act of August 24, 1912.

Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 16, 1918.

Subscription Price, $4.00 a year (Ten Numbers)
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BOSTON
WRIGHT & POTTER PRINTING COMPANY
32 DERNE STREET

Vol. XI JUNE, 1924 No. 6

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PAPERS AND DISCUSSIONS

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THE CONTROL OF OIL POLLUTION IN RHODE ISLAND

By Stephen DeM. Gage,* Member, Boston Society of Civil Engineers

(Presented before the Sanitary Section, March 5, 1924.)

Every age has its special features which bring new sanitary problems. The present may perhaps be called the Petroleum Age. The production, transportation and handling of the immense volumes of petroleum and petroleum products required for motor vehicles and power boats, for fuel and for numerous other uses have brought the attendant evils of oil pollution of public waters. So widespread has this pollution become, and so great is the damage that is being caused, that a cry for relief is arising from all parts of the country. Through long experience and much experiment sanitary engineers have learned to deal more or less successfully with the problems arising from pollution caused by city sewage and by the waste products from a variety of industries. Now we must find and apply remedies for this new form of pollution.

In the hope that our experience may be of some value to sanitary engineers who are now attempting to cope with or must shortly attack this problem, I propose in the following pages to discuss the cause and effects of oil pollution and to describe the methods by which we have, in a very large measure, succeeded in controlling it in Rhode Island. As my own connection with the special Board which was created to clean up Rhode Island public waters did not begin until many of these control measures

* Sanitary Engineer, Board of Purification of Waters.

were well under way, in describing these measures I am merely acting as historian. The credit for what has been accomplished in remedying the very offensive conditions which existed in the territorial waters of Rhode Island prior to 1920 belongs to the members of this Board and to its Inspector of Oil Plants, Capt. John T. Smith.

Our situation in Rhode Island with regard to public waters is somewhat peculiar. Narragansett Bay extends practically three-fourths of the way from the southern end to the northern end of the state, with an easterly arm which extends well over into Massachusetts. About 16 per cent of the total area of the state is included in the waters of Narragansett Bay. Tributary to Narragansett Bay at its head are the Blackstone River, which drains an area of about 488 square miles, only about 30 per cent of which is in Rhode Island, and the Ten Mile River, with a drainage area of about 56 square miles, only about 11 per cent of which is in Rhode Island. In addition, the drainage area tributary to Narragansett Bay from Massachusetts through Mount Hope Bay comprises something like 600 square miles outside the state of Rhode Island. On the southwest about 58 square miles of the drainage area of the Pawcatuck River is in the state of Connecticut. All of these drainage areas lying outside the state contain a considerable manufacturing population, from which both domestic sewage and industrial wastes are contributed to Rhode Island public waters. The close inter-relationship between Rhode Island and the states adjoining in questions of pollution is illustrated by the drainage map.

In endeavoring to improve the condition of most of our Rhode Island waters, therefore, we have to consider the pollution entering from outside as well as that which originates within our own state. Our methods for controlling oil pollution, for example, can never be fully effective until a similar control becomes effective in Massachusetts and Connecticut. Already there is agitation for a national control of oil pollution, and at the time this is written there are a number of acts before Congress which are aimed to accomplish this purpose.* As oil is practically

* Sixty-eighth Congress, First Session, S. 1942, S. 3968, H. R. 51, H. R. 203, H. R. 612, H. R. 690, H. R. 3319, and H. R. 6256.

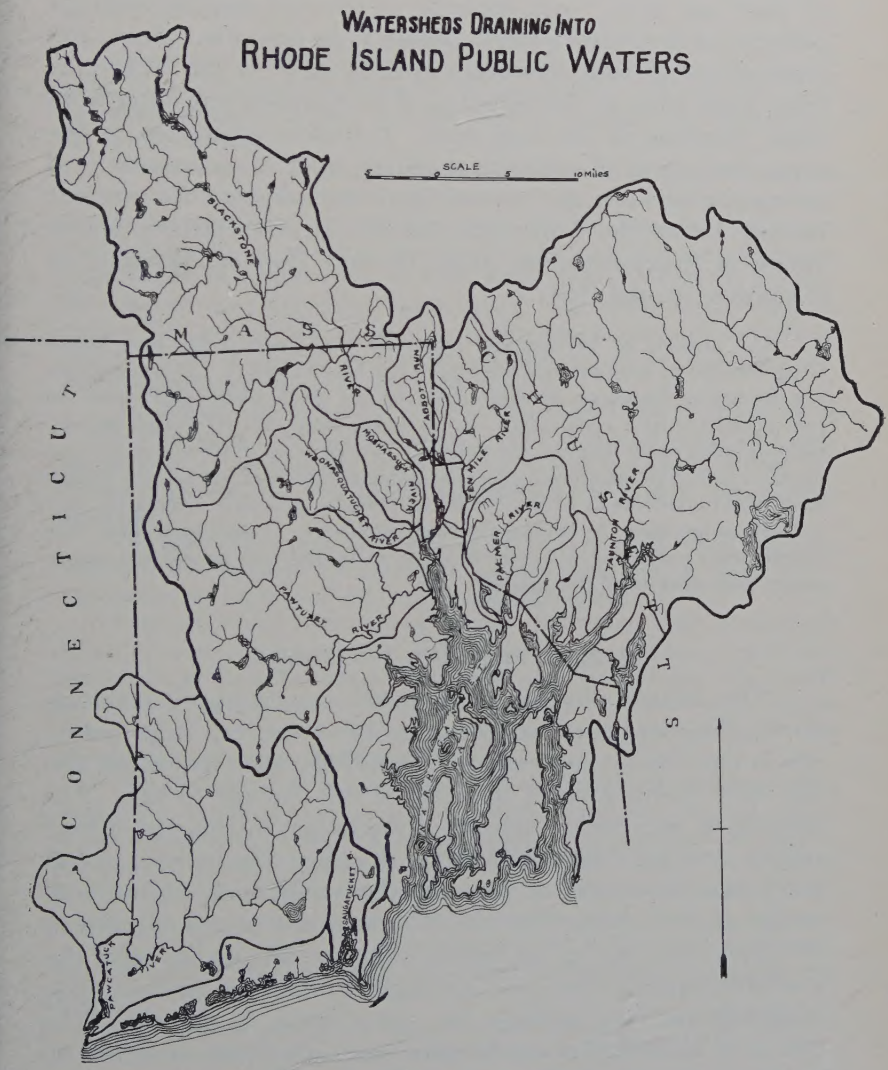

FIG. 1. — DRAINAGE MAP.

indestructible, and may travel for many miles under the influence of wind and tides, some measure of national control over the pollution of interstate waters appears to be desirable. State and national jurisdiction, however, extends only to the three-mile limit, while some of the pollution of local waters originates from ships traveling on the high seas. Complete protection of our ocean front from oil pollution therefore involves an international agreement between the various maritime nations. At a recent hearing before the Committee on Rivers and Harbors of the House of Representatives, Hon. Herbert Hoover, Secretary of Commerce, stated that:

> The problem of international treaty on this question has been before Congress, and an international conference has been talked of. There has been a great deal of discussion between ourselves and the British, chiefly over the preliminaries of such a conference. It has been sought that we should, on both sides, develop some program for policing. There is no difference of opinion on either side as to the necessity for controlling pollution at sea, but the British have raised questions as to the method of policing, and have appointed committees, as we have, to investigate these problems. I anticipate that that international conference will come on at an early date and we will attempt to secure some solution of the question.

Damage from Oil Pollution

The damage directly or indirectly caused by oil pollution during the past ten or a dozen years has been very large and its effects have been widespread. Probably the most important and the most far-reaching in its effect is the damage to fish. The fisheries of the country are one of the important sources of food supply, and anything which tends to reduce the number of fish which may be caught, or to render them unfit for food, not only strikes at the livelihood of the fishermen and others engaged in the many branches of the fishing industry, but by reducing the available supply of low-cost food tends to raise the price of other foodstuffs and thus increase the cost of living in general. The effects of oil pollution on fisheries were admirably summed up by H. S. Davis, Pathologist of the United States Bureau of Fisheries, in a statement made at a recent hearing before the Committee on Rivers and Harbors of the National House of

Representatives in January, 1924, from which the following abstracts are taken:

Oil pollution may affect fish and other marine organisms in four different ways, namely, through the formation of a surface film, emulsification, sedimentation, and toxic action. The first three are mechanical in their action, the fourth chemical.

The surface film, while it has no direct toxic action on fish, may seriously decrease the amount of oxygen in solution since it prevents the free interchange of gases between the water and atmosphere. The oily film also tends to prevent agitation of the surface of the water by winds and the streaming movements due to evaporation, both of which are of great importance in aeration. Since in most cases oil-polluted waters contain large quantities of sewage, the surface film undoubtedly aggravates the deoxidizing effect of the sewage. As a result the water may become very deficient in oxygen, with the consequent asphyxiation of the fish and other animals.

The heavier constituents of crude oils may sink to the bottom, forming a layer of lumps of thick, tarry material which it is claimed has in some cases accumulated to considerable depths. In this way the spawning beds and feeding grounds of fish may be seriously affected and in some cases entirely destroyed.

The toxic effects of oil pollution are due to those constituents which are slightly soluble in water. In general, it has been found that the lighter, more volatile oils, are much more toxic than are the heavier oils.

The most direct injury to marine and anadromous fishes undoubtedly occurs in their early stages. The eggs of most marine fishes are lighter than sea water and float near the surface, where they readily come into contact with the surface film and emulsified oils. After hatching, the nearly helpless young live for a time near the surface and are even more susceptible than the eggs to injuries from floating oil.

Probably one of the most serious effects of oil pollution on marine fisheries is due to its repellent action. Fish are active animals, and the wide expanse of our coastal waters affords them every opportunity to escape from noxious substances. It is probable that in the majority of instances they will be repelled by areas of pollution. Many complaints have been received which refer to the almost total absence of fish from areas where formerly they were very abundant. As many important fisheries are prosecuted close to shore, this will have an effect on the fisheries almost as disastrous as if the fish were killed.

A further source of loss is the petroleum flavor which may be imparted to fish in oil-polluted waters and renders them unfit for market.

Turning to the effect of oil pollution on oysters, clams, and other shellfish, we find the evidence is even more conclusive. These animals in the adult stage are for the most part fixed in position or move very slowly. This renders them more liable to injuries from oil pollution, and numerous cases have been

reported of the destruction of oysters and clams by the deposit of a layer of oil at low tide.

It is also important to bear in mind that mollusks and crabs have free-swimming larvæ which float near the surface, and laboratory tests have shown that these larvæ are quickly killed by a film of crude oil. There can be little doubt that in oil-polluted areas there is an enormous annual loss among the young of these animals, but the larvæ are so minute that it is almost impossible to determine the extent of this mortality.

Not to be ignored is the destruction of aquatic vegetation which, directly or indirectly, serves as food for fishes. This is a matter of direct observation in the case of the larger seaweeds and other plants between tide marks, and we are justified in assuming that it is equally true of the microscopic forms. Since the aquatic plants, large and small, form the ultimate source of food of all marine animals, the importance of this wholesale destruction of plant life is at once manifest.

In the report of the hearings noted above, Mr. E. W. Nelson, Chief of Bureau of Biological Survey, is quoted as follows as to the effect of oil pollution upon wild fowl:

> In many parts of the United States wild fowls and other aquatic life are being destroyed in large numbers through the dumping of oils in both inland and coastal waters and through leakage of oil-pipe lines and waste oil thrown off from manufacturing plants, gas companies, etc. The wild fowl are destroyed as a result of their feathers becoming saturated with the oil, and the birds then being unable to rise from the water die from exposure to the cold, or drown.
>
> The observations of members of this bureau are supported by those of numerous other individuals and agencies, including officials of State game departments, members of sportsmen's organizations, and conservationists.

This statement from Mr. Nelson is accompanied by reports of destruction of duck and other wild fowl from practically all parts of the country where oil pollution exists. Two instances of destruction by oil in Rhode Island are noted elsewhere in this paper.

Second only in importance to the destruction of fish and of wild fowl is the greatly increased fire hazard to water-front property and to shipping caused by oil pollution. Gasoline, kerosene, and some of the lighter fuel oils are inflammable even when spread out on the water, and their presence on harbor waters is a constant fire menace to all combustible property in

the vicinity. The difficulty of subduing an oil fire, once it becomes started, is well known. Although the heavier oils may not burn readily when spread out on the water, wooden docks and other combustible material on the water front are rendered much more inflammable when smeared with them. Directly or indirectly, oil has been responsible for many large fires on the water front during recent years.

Next in importance is the effect of oil pollution upon our bathing beaches and summer resorts. Not many will attempt to go bathing if the water is covered with oil, the effects are too hard to remove afterwards. The oil washes upon the sand and spoils the beach for pleasure purposes. Eventually, through the action of waves and tides, it may be covered or so mixed with the sand that it is not particularly noticeable, but under a hot sun it will soften up, ready to smear the careless person who steps or digs into it. Floats, landing stages, docks, etc., become coated with oil, ready to leave a black mark on bodies or clothing of the unwary. All this destroys the usefulness of a beach as a summer resort. Large investments which have been made in shore resorts, in summer cottages, etc., are affected. There is actual depreciation in property values. Pleasure-boat owners complain that they cannot keep their craft tidy. Where formerly they painted in the spring they now have to haul out, scrape and repaint every few weeks. These are conditions which prevailed in certain parts of Narragansett Bay a few years ago, conditions which still prevail at numerous places east, west and south. For this reason large numbers of people are forced to travel farther afield to obtain their daily swim in salt water, while numerous others, who have been accustomed to make frequent visits to some convenient bathing beach during the summer, are now able to enjoy that privilege only at rare intervals.

It is claimed that the mixture of crude oil and salt water is very likely to cause skin eruptions and similar trouble among bathers. Two or three years ago diseases of this character were more or less general at shore resorts along the North Atlantic coast, and in many instances this was attributed to oil pollution. Whether oil was a contributory cause in these epidemics we do

not know, but we certainly believe that any factors which tend to decrease the facilities for healthful sport and recreation which may be enjoyed by any considerable number of people during the summer cannot help but have an unfavorable effect upon their health and comfort.

Some Typical Oil Spills

Practically all oil spills are preventable, and many of the measures which we have taken to reduce oil pollution have been put into operation to prevent recurrence of an oil spill or have been suggested by such a spill. Before proceeding with the discussion of these different preventive measures a brief review of some typical oil spills which have occurred in Rhode Island may be of interest.

During the winter of 1920–21 an unusual amount of newspaper comment was caused by two oil spills which resulted in the destruction of large numbers of wild duck. In the first case the oil came down in considerable quantities through the Providence sewers during a heavy storm, when the tanks at the chemical precipitation tanks were being by-passed, and collected in a cove just below, in which flocks of wild duck are accustomed to alight at this season. Whether oil came first and the ducks dropped down into it, or whether the oil flowed around the ducks while asleep on the water, is not known, but in any case these ducks became so smeared with thick oil that they could not fly or feed, and most of them died a lingering death. Although a searching investigation was made at the time, the source from which this oil came and the cause of the spill was never satisfactorily determined.

In the second instance oil came into the same cove from a spill at the plant of a public-service company located on the water front a short distance above. In this instance the spill occurred during extreme cold weather, and as the ducks which were caught in the oil were unable to ruffle their feathers as protection against the cold, hundreds of them were frozen to death during the night. The cause of this spill was due to lack of foresight on the part of the engineers who designed the oil-storage system and to carelessness of an employee. The company had

one large storage tank, and a smaller tank in which oil drawn from the storage tank was heated before being used. Both tanks were closed at the top and vented, the top of the smaller tank being at a lower elevation than that of the storage tank. An employee opened the valve between the two tanks to refill the small tank and was then called away to attend to something else. The small tank filled and the oil overflowed through the vent, flooding everything in the vicinity, including the harbor. To prevent a recurrence of an accident of this kind was a simple matter. The vent pipe on the smaller tank was carried up to an elevation above the top of the storage tank, and the oil after filling the tank could simply rise to the level of that of the storage tank, with no possibility of overflow.

Poor design of the oil-storage system and carelessness on the part of employees also caused a recent spill at a textile plant using oil fuel. In this case the fuel tanks were located on low ground, a pipe being carried up to a manhole to permit tank trucks to make delivery at the street level. The engineer of the plant miscalculated the amount of fuel on hand and permitted a truck load of oil to be delivered when his tanks were already nearly full. The surplus oil overflowed the tanks and found its way through near-by drains to the river.

Another instance of carelessness combined with ignorance was the cause of a considerable oil spill at another textile plant. A new driver delivered a truck load of oil at the gate, took his receipt and was instructed to discharge into the storage tanks through a manhole in the yard, which was pointed out to him from a distance. In the course of a few hours oil was reported in quantity on the river some miles below, and was eventually traced back to this plant. Investigation showed that the driver had unloaded 1,500 gallons of perfectly good fuel oil into the manhole of a surface drain instead of into the oil-storage system. In this case the employees at the plant were guilty of negligence in the fact that they did not take pains to see that the driver discharged his load at the proper point, and the driver was negligent in not making sure of his delivery point before unloading.

A similar instance of carelessness on the part of a driver in which a serious spill was narrowly averted occurred at a large

laundry in Providence. The truck driver inserted his delivery pipe into the storage tank which he supposed to be empty, opened the discharge valve, and went to a neighboring lunch room for breakfast. The storage tank happened to be nearly full instead of empty, and in a short time persons going by on their way to work were surprised to see a stream of fuel oil flowing over the sidewalk into the gutter. One of the city officials happened to be one of the first to notice this, and with unusual energy traced the stream back to its source, routed out the truck driver from his morning meal and had the flow of oil shut off. Fortunately the catch basin was some distance away, and the oil was all held in the gutter and did not get into the city sewers. In another instance, however, when the head of a tank truck broke away from the barrel while a truck was proceeding along the public highway, a local town official ordered the truck driver to spill his load directly into a catch basin in order to prevent messing up the road and gutters. The oil flowed under the road, through a second catch basin and out into the harbor, where it was thrown up on a stone embankment by opposing winds. A rather humorous side to this incident was caused by the fact that some one succeeded in setting fire to the oil on the embankment and the fire department were called out to extinguish the blaze.

In a number of instances spills have occurred at oil-burning plants which can be attributed to failure to appreciate that every part of the oil storage and distributing system should be so laid out that it can be inspected for leaks. In one instance the fuel oil stored at an industrial plant was found to be leaking through the ground into the river. At this plant most of the pipes connecting the storage tanks to the boilers were underground, and it required a considerable amount of excavation and some weeks' delay before the leaks were found and the spill stopped. The total amount of oil which escaped into the river amounted to many barrels, although the leakage at any one time was relatively small. During this spill a boom was constructed across the cove where the oil was coming into the river, and transfer of oil pollution to waters below was effectually stopped long before the leaking pipes had been located and repaired.

In another instance oil was reported to be escaping into

tide water in considerable quantities from the public sewers of Pawtucket. With the assistance of employees of the sewer department this oil was traced back through the sewers to a manufacturing plant using oil fuel. In this plant the oil piping was run in galleries, and in order that service cars might be trundled across the floor at will these pipe galleries were covered with heavy cast-iron covers. On removing these iron covers it was found that the packing of a flange on a four-inch pipe carrying oil at about 30 pounds' pressure had blown out. Oil had been running from this opening through a drain into the sewers for a number of days before its presence in the river was reported. When the amount of oil which had been spilled and the financial loss were determined this company was only too willing to establish a regular inspection of the entire oil-storage and piping system.

In the great majority of cases spills on shore at the oil companies are prevented from reaching the public waters by dikes, lead-back drainage, and similar protective measures. One spill occurred a number of years ago, however, which this class of protection would not have prevented. There were two tanks close to the shore containing heavy asphaltic oil which had been in storage for some time and had been allowed to cool. Oils of this character have to be heated before they will become sufficiently fluid for pumping or handling and these storage tanks were equipped with the customary steam coils for heating the oil. It may be true that oil and water will not mix, but when heavy oil and water are heated together up to a certain temperature a violent frothing is very likely to occur. In this particular instance apparently the steam coil had frozen or had burst, allowing the water to enter the tank. After the steam had been turned on for a time there was an eruption of oil froth from the top of the tank which was spread by a high wind over a wide area, causing damage to buildings and other property in the vicinity, and was carried by the tides to various parts of the bay.

Before our system of oil control was made effective, spills during the unloading of tankers at the dock were not uncommon, the usual cause being the bursting of the hose or the blowing out of a hose coupling. In one case a pipe connection on the dock

gave way, but as the oil was cold and the friction head high, the engineer in charge of the pumps on the tanker did not notice the difference, and continued to pump oil into the harbor at a rate of something like 50 barrels per minute for some time. Under present conditions, with a man on deck watching the pressure gauge with his hand on the pump control and another man on the dock at the valve in the pipe line, and with proper safety devices to hold back the oil in case of accident, a spill of this kind would be unlikely to result in any appreciable amount of oil escaping into the harbor.

Unless properly controlled, serious oil pollution may be caused by the pumping of bilges or by pumping out water ballast while oil tankers and oil-burning ships are passing through coastal or inland waters. In one instance a United States Navy oil carrier, while en route to Fall River to load with fuel oil, anchored in the lower part of Narragansett Bay and proceeded to pump out water ballast, which was of course highly charged with oil. This oil came ashore on beaches over a considerable area and spoiled the bathing season for large numbers of summer cottagers. In this instance the Board promptly appealed to the Secretary of the Navy, and orders were issued to commanders of all naval vessels that state regulations against pollution of navigable waters must be observed in all cases. As the lower part of Narragansett Bay is the seat of manœuvres by a large fleet of naval vessels each summer, and as a considerable proportion of these vessels use oil fuel, the co-operation of the Navy Department is very necessary if we are to keep these waters free from oil.

Another type of oil spill is that due to "the peril of the sea," which there seems to be no way to prevent. In October, 1922, the oil tanker "Swiftstar" went aground off the south shore of Block Island, and most of the cargo of 70,000 barrels of oil had to be pumped overboard before the ship could be pulled off the rocks. This oil not only smeared the west shore of Block Island for a wide distance but was driven by the winds and tides to the mainland, some fifteen miles distant, where it did much damage to fishing gear, docks, etc. Fortunately this accident occurred in the late fall, and although bathing beaches on the mainland

were quite thoroughly smeared with oil, much of the damage disappeared during the winter storms. In June, 1923, however, a large quantity of oil came ashore at Narragansett Pier and Scarborough Beach. As these were well-known summer resorts, whose principal attraction is the bathing beach, there was an immediate protest to the Board. In this instance the oil came in from outside the three-mile limit, and although we immediately got into communication with all the companies operating oil tankers in these waters at the time, we were never able to definitely locate the vessel from which it was discharged or to determine the cause.

The Rhode Island Anti-Pollution Law and its Administration

For many years efforts were made at intervals to obtain legislation to control the increasing pollution of public waters in Rhode Island. It was not, however, until the general public became very much aroused by the damage caused to the oyster-growing industry and to boats, bathing beaches, etc., by oil pollution, that any concerted effort was made to obtain legislative action to reduce the pollution. In 1920 the General Assembly passed an act prohibiting pollution of public waters, and creating a special board of three men to study conditions and administer the provisions of the act. This Board, known as the Board of Purification of Waters, came into existence September 1, 1920. The law is quite broad in character, both in its interpretation of what constitutes pollution and in the administrative powers granted to the Board, as is illustrated by the excerpts which are appended.

So far as I have been able to determine Rhode Island is the first state to attempt to develop a systematic control over pollution by oil. As there were no precedents to go by, the Board was forced to build on untested ground, learning by experience what methods would prove effective and reasonable. They were fortunate, however, in the fact that while there may be an economic necessity for our public waters to become the ultimate point of disposal for city sewage and trade wastes, there is practically no reason for the discharge of oil into such waters. In fact, such

discharge constitutes an economic waste which it is to the interest both of the owners of that oil and of the general public to prevent. Control measures, therefore, had to deal almost entirely with prevention rather than with methods of treatment.

Proceeding under the authority granted by this law, therefore, one of the first official acts of the Board was an order establishing rules and regulations to prevent the discharge of petroleum products into the public waters of the state. Alleging that this order was unlawful and unreasonable, certain of the oil companies appealed to the Supreme Court for a reversal of the order. This appeal was dismissed by the court, and the regulations which are appended became for all practicable purposes a part of the statutory law.

The appeal to the Supreme Court was a test of the authority of the Board to issue regulations. Once this question was decided the oil companies accepted the regulations without question, and since that time have co-operated with the Board in every possible way to prevent oil pollution.

It is significant of the policy of the Board that in control of oil pollution as well as of pollution by sewage and industrial wastes remedies have always been worked out by co-operation between the Board or its agents and the parties causing the pollution. When evidence is obtained that any person is polluting public waters within the meaning of the law these persons are invited to meet with the Board for a conference as to what measures must be taken to remedy the offensive conditions. The full data obtained by the Board in its investigations are generally laid before the representatives of the offending parties, and cause and effect are made clear to them. Communities and industries as a rule wish not only to observe the law but to be free from the stigma of causing any offense against the public interests, and with this spirit practically everything that is desired in the line of cleaning up the public waters can be accomplished through co-operation. The law is always there but this is kept in the background. Since its organization the Board has never found it necessary to enter an order against any person for polluting the public waters or to prosecute for any violation of the law.

In the enforcement of the regulations prohibiting discharge

of oil, the Board employs an inspector whose duty it is to visit all oil-handling plants regularly, to observe the methods by which the oil is being handled, and to bring to the attention of the Board and of the oil-handling companies any points where there is possibility that oil may escape into the public waters. In a very large measure the clean-up which has been made in the oil-pollution situation within the last two years has been due to the conscientious efforts of this inspector. Being a practical water-front man who understands the shipping end of the situation the suggestions which he may make to the agents of the oil companies are of a practical nature. In case a spill occurs, either on the tidal water front or on any of the streams, this inspector is notified by phone and proceeds immediately to the site to determine how and why the spill occurred, to devise remedies to prevent the pollution spreading to other points, and to see what proper precautions are taken to prevent recurrence of a similar spill in the future. One or more members of the engineering staff are also usually within telephone call, and when necessary can be detailed to cover an oil spill, working either with the oil inspector or independently if it so happens that this inspector is out of touch with the office. In addition, a man with a power boat patrols the navigable waters regularly, looking for evidence of oil, and keeping a record of the location and amount of oil observed. If oil is noted at any point, the patrolman traces it back to the source if possible and immediately reports the facts to the office.

As I have noted elsewhere, a considerable proportion of the oil finding its way into our public waters has come from industrial power plants and other places where oil was being used as fuel. It was evident that we must extend our system of oil control to cover all places where oil was being stored or handled in appreciable quantities. During the past year, therefore, one of our assistant engineers has been making a systematic survey of places where oil is being used as fuel. As this engineer has other duties to perform, and as we already have a list of over 350 oil-burning establishments, it will be some time before this survey can be completed. During these surveys the attention of the superintendent or other official of the plant is called to unsafe

points in the oil storage and distributing system and suggestions are made as to precautionary measures. A detailed report on the conditions found at each plant visited, with a sketch plan of the oil storage and piping systems, and of all drains, sewers and other outlets through which oil might find its way into the public waters, is filed in the office for reference. The value of such a survey is twofold. It brings to the attention of the oil user the fact that he is expected to use every precaution to prevent spills or oil leakage, and it places on file classified information which frequently is a great aid in quickly tracing an oil spill back to its source.

One of the essential things in attempting to control oil pollution is the prompt reporting of a spill in order that immediate measures may be taken to localize and clean up the polluted area. The oil companies and some of the larger manufacturers are very prompt in reporting accidental spills, thereby saving the employees of the Board much time in tracing back observed pollution, and enabling them to check up on the remedies being taken to minimize the damage. Much valuable assistance has also been received from volunteers who are in a position to note the occurrence of oil on the water and report it immediately to the office. The harbor masters of Providence and other smaller harbors, the various pilots, the officers and members of the different yacht clubs, and the proprietors of shore resorts and bathing establishments are all on the watch for oil. The commanders of the United States Coast Guard Stations have also assisted by logging and reporting the coming ashore of any considerable quantities of oil on the ocean front.

Sources of Oil Pollution

Something like fifteen years ago an effort was made to develop Providence as a seaport. Although the development of the port for general freight has perhaps not proceeded as rapidly as its proponents would have desired, in one respect Providence Harbor and Narragansett Bay have been developed extensively. One oil company after another has located receiving and distributing stations in the upper part of Narragansett Bay, where both

water and railroad facilities are excellent, until Providence has become the greatest oil port of New England, and perhaps of the northern Atlantic coast. Four large oil companies and one power plant operate seven large receiving stations on the water front of Greater Providence, and three other oil companies have receiving plants under construction. Another oil company and the United States Navy Department each have oil receiving and distributing stations in the lower part of Narragansett Bay. In addition there is a large oil refinery and a number of smaller receiving stations in Fall River on an arm of Narragansett Bay, whose only outlet is through Rhode Island waters. In 1923 the amount of oil brought into the port of Providence by water amounted to over twelve million barrels, or over six hundred million gallons. We might well describe this as a river of oil flowing through Rhode Island.

Among the large companies the Standard Oil Company operates a large and complete oil-refining plant, receiving the crude oil by water and reshipping a portion of the refined products by water to other ports for distribution. The Texas Company receives large amounts of oil from which the lighter distillate has been removed, separates this product in their refinery into middle oils and asphalt, and ships the middle oils by water to other refineries for final treatment.

During the transfer of the oil from vessel to shore or from shore to vessel the danger is always present that the hose or flexible connection may be broken, and that a large spill may occur before the pumps can be stopped and the gates closed on the pipe lines. Another potential source of oil pollution occurs during the passage of oil-carrying vessels and ships using oil fuel through our navigable waters, either through damage to the vessel itself or through pumping out of oil-bearing water ballast or bilge water during transit. In some ports the cleaning of oil tanks, etc., on tankers and oil-burning ships during overhauling at dry docks and ship repair yards is also said to be the cause of much oil pollution of adjacent waters. Every steam or gasoline propelled boat contributes its quota of oil pollution, which though small in each individual instance may be appreciable when the traffic is heavy. The latter causes have been looked

upon as unavoidable, but it is believed that by proper design and operation of marine engines this evil can be very largely eliminated.

At the shore plants, the oil companies all have storage tanks, and car and truck loading yards, with a network of interconnecting pipe lines. Here there are numerous points where a leak or a broken pipe or the collapse of a storage tank might result in the escape of oil in considerable quantities. As possible sources of oil pollution, therefore, we must consider the oil company plants as of major importance.

Second in importance are the industrial plants using oil fuel, where similar conditions exist on a smaller scale and where there is always danger that through carelessness or accident oil may escape into our waters either directly or through sewers or surface drains. Most of our troubles from oil pollution in Rhode Island have originated from one of these two major sources. There are, however, a number of lesser sources which also have to be constantly kept in mind. Every sewer system discharging into public waters is also a potential source of oil pollution. Not only do many of the industrial plants using oil fuel have connections to the municipal sewer system, but there are large numbers of office buildings, apartment houses and private homes using oil fuel for heating, and the natural outlet for any oil spilled at any of these is into the public sewers. Public and private garages also constitute a source from which oil may find its way into the sewer systems, although regulations have been adopted in the larger cities prohibiting the discharge of any oil or gasoline into the public sewers from garages. These regulations were adopted primarily to reduce the danger of explosion, but when rigidly enforced they also serve to keep considerable oil out of the public waters.

Two other sources of oil pollution which may be mentioned are the use of oil or similar substances for street oiling and the use of oil in anti-mosquito work. If the street oiling is overdone, surplus oil may find its way over the ground into a convenient water course or into the public sewers or surface drains. The oil used in catch basins and on ponds and swamps to prevent mosquito breeding is likely to be flushed out into the public waters

unless special precautions are taken to prevent it. In addition, the condenser waters from practically all power plants and the wastes from many industries carry lubricating and other oils, and these all have to be considered in any attempt to control oil pollution.

Most gas plants use considerable amounts of oil for enrichment of low-grade gas, and are therefore potential sources of oil pollution. The wastes from gas works also contain substances of an oily nature which float on the water and resemble oil pollution. The heavier tarry matters from gas works, which do not float at first, usually carry some of these lighter bodies in suspension or in solution which later may be released by changes in temperature or by agitation. For this reason the methods of handling the wastes from gas works as well as their oil-handling facilities must be taken into consideration in any attempt to eliminate oil pollution.

Preventing Pollution from Shipping

The methods and devices for preventing oil pollution may be roughly separated into three general groups, — the marine group, which applies to the construction, equipment and operation of vessels used to convey oil by water and to ships using oil fuel; the land group, which includes the storage, handling and transportation of oil on shore; and an intermediate group, which includes the transfer of oil between vessels and shore stations.

The older type of vessel used in transporting bulk oil is usually a converted freighter with oil tanks built into holds which had originally been designed for general cargo. In this type of vessel there is more or less space between the tanks and the outside plating or planking of the vessel, both on the sides and along the bilge. In addition to the usual sea cocks opening into the bilge, an extra set of sea cocks is provided to permit the tanks being filled with water ballast. In this type of vessel, as well as in most of the oil-burning steamships, the bilge serves as a collecting place for any oil which may leak from the tanks as well as for any sea water which may leak in from outside. Pumping out the bilge at intervals is of course necessary to keep the vessel

seaworthy, but this means that oil pollution is caused unless some means are provided to retain the oil.

In the more modern type of oil-carrying vessel the outside plating of the vessel forms the outside wall of the oil compartment, which extends through to the keel. There is thus no bilge except immediately under the engine and boiler rooms and practically no bilge water. With this type of construction the pressure of the oil or of the water ballast contained within the tanks balances the pressure of the water on the outside and leakage is reduced to a minimum. The nature of the business is such that an oil tanker usually has no return load and must use water ballast to trim the boat so that she may be seaworthy when in deep water. Taking on water ballast is usually accomplished by opening the sea cocks and allowing sea water to enter the oil tanks up to the desired level. Some of the oil companies have issued explicit instructions to their boat captains as to the best method of taking on water ballast to prevent the possible escape of any oil which may be left in the tanks. It costs money to keep a large vessel in commission, and the operating company naturally desires to have the vessel ready for loading when she reaches the dock. Most of these tankers ride high, and become very cranky to navigate when they are empty, and for this reason it was formerly the practice to delay discharging ballast until the last moment, with the result that the oil-laden water was pumped overboard after the vessel had come inside the bay, where oil pollution would be most objectionable. Under the regulations established by the Board pumping out bilges or the water ballast from oil tankers is absolutely prohibited in Rhode Island waters.

It has been proposed that the water ballast be discharged after the vessel arrives at the dock, and that the oil-laden water be pumped to a separator on shore. For some time this has been the practice at some foreign ports. As noted previously, however, this means a net loss in operating time and in money to the vessel. The oil companies thoroughly recognize the fact that the pumping of bilges and water ballast in inshore waters may cause a serious oil nuisance, and they also recognize the fact that if any amount of oil is pumped overboard outside the three-mile

limit it may be brought ashore by the wind and the tides. For some time a joint committee of the Department of Commerce, the Department of the Interior and other Federal departments, with the co-operation of some of the oil companies, has been making an investigation of types of oil separators which can be installed on vessels and thus permit the pumping overboard of water ballast, etc., at any point where it would be most convenient

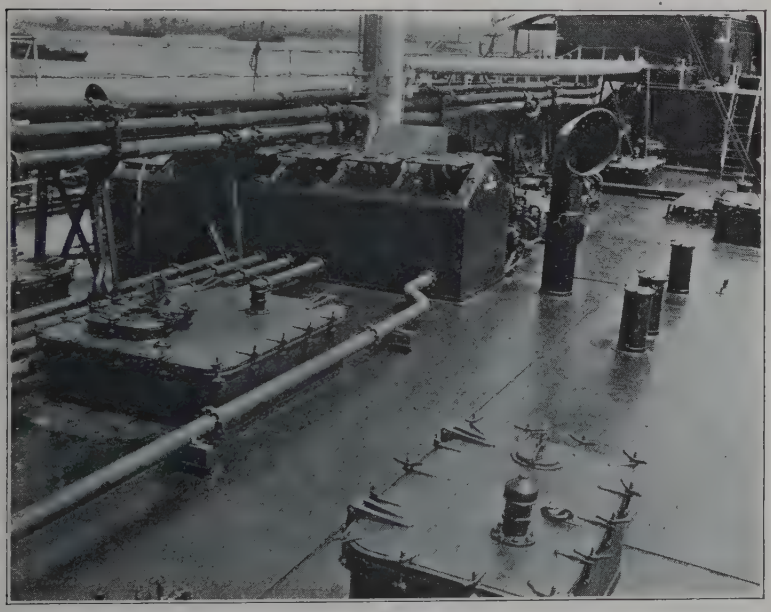

FIG. 2. — DECK OF AN OIL TANKER.

and economical to do so. From informal reports of their investigations it seems probable that a satisfactory apparatus of this sort will be developed in the near future.

In some cases the condenser waters discharged by steamships carry with them objectionable amounts of oil. Such apparatus could be used for separating oil from condenser waters as well as from bilge and ballast water. If refined products are to be placed in tanks which have previously been used for crude oil, or if repairs on these tanks are needed, the tanks must be

cleaned of all oil sludge and residue. The discharge overboard of the slops resulting from cleaning oil tanks is specifically prohibited in the Rhode Island regulations. Possibly a properly designed separator on the ship would also serve to take care of these slops, and thus permit tanks to be cleaned in quiet inshore waters where conditions are favorable for work of this kind.

The bulwarks of oil-carrying vessels are usually of tight construction and sufficiently high to hold back any oil which may be spilled on the deck if proper precautions are taken to prevent the escape of such oil through the scupper holes. One of the duties of our inspector is to see that scupper holes are closed while an oil tanker is loading or unloading. In the majority of cases the method of closing these scupper holes is by means of wooden plugs driven in with a mallet. In some vessels bars or gratings are built into the scupper holes in such a manner that wooden plugs cannot be conveniently employed, and various methods have been resorted to in order to effectively close holes of this type. One of the most successful methods is to force a loose plug of waste attached to a string into the inboard portal of the scupper holes and fill in above this with cement mortar. On those vessels where the scupper holes have a built-in grating flush with or raised slightly above the deck, the gratings may be covered with canvas or heavy paper overlaid, with a layer of cement. Either of these methods provides a satisfactory seal which can be readily broken up and removed when the ship is ready to sail.

As an added protection against the further spread of any oil which may be accidentally spilled overboard, one oil company places floating booms between the dock and the bow and stern of their tankers while they are being loaded or unloaded.

The rupture of the unloading hose through excessive rocking of the boat by waves thrown up by passing vessels has been the cause of more than one oil spill. It is now the custom for all oil tankers while loading or unloading to display a red flag by day or a red lantern by night as a caution signal to passing shipping. All steamship companies operating in Rhode Island waters have been officially requested by the Board to instruct their captains to proceed at slow speed while passing oil tankers displaying this

signal, and the significance of this flag and the necessity that it be respected have been called to the attention of all local pilots through the State Pilot Commission, and also to the attention of the various harbor masters.

Transferring Oil between Tanker and Shore Station

Transfer of bulk oil from vessel to shore and *vice versa*, as well as transfer from point to point on shore, is always accomplished by pumping or by gravity. In order to allow for movement of the vessel through rise and fall of the tides, etc., this transfer must be made through some sort of flexible connection. A few of the oil companies use iron pipe connections with swivel joints, but as these respond less readily to sudden changes in position and are difficult to handle because of their weight most of the companies prefer to use hose for this purpose. Connections between hose and pumps and pipe lines are always made with a bolted flange coupling. The weak point in a hose connection is in the coupling, and many oil spills have been caused by a coupling blowing out. It is very difficult to put a coupling on a large hose in such a manner that it will stand up under continued use with the pressures ordinarily used in unloading. Within the past two or three years the hose manufacturers have brought out a special type of hose for this purpose which has to a large extent overcome this difficulty. In this type the coupling has a long ribbed nipple which extends well back into the hose. The wire reinforcement is brought up over this nipple, and after the outer rubber casing has been put on, the hose, nipple, reinforcement, and outer casing are all vulcanized into one solid unit. We have never had an instance where a coupling of this type has blown out.

The practice of different oil companies as to size of unloading hose varies widely. Some companies prefer to use a single line of 10-inch hose, others use 8-inch or multiple combinations of 4 and 6 inch. The pressure which this hose must withstand depends upon the kind of oil and its temperature, as well as upon the usual hydraulic factors of length and size of pipe line, elevation of tank into which delivery is to be made, etc. The usual pressures are 60 to 80 pounds at the pump, but with a cold heavy oil and orders to hasten unloading these pressures are likely to

be exceeded at times. The hose is usually tested at the factory and guaranteed for pressures up to 80 pounds per square inch. So far as we have been able to learn, pressure tests are never made on this hose after it leaves the factory, although we feel that such tests should be made at regular intervals as a safety precaution. All hose is, however, carefully inspected for cracks

FIG. 3. — OIL DOCK, SHOWING CONCRETED SECTION UNDER UNLOADING HOSE.

Pipe lines are in wooden conduit which is packed with sawdust to absorb leaks.

and possible weak spots each time it is used. The average life of hose for pumping is about eighteen months, or for the delivery of something like 2,000,000 barrels of oil. Hose which has been discarded as unsafe for pumping pressures can still be used about the plant, for loading barges, or wherever storage tanks pressures only are applied. The total usable life of oil hose is therefore more than double the figure stated above.

The unloading pumps are a regular part of the mechanical equipment of an oil tanker and their operation is under the direction of the chief engineer and his assistants. In the more modern vessels, pump controls, pressure and temperature gauges are located on deck, where the unloading can be watched by the pump man. The unloading hose, however, is usually a part of the equipment of the shore station. In Rhode Island it is required that a man be on duty continuously at the pumps during unloading, and that a man be stationed at the valves at the dock end of the pipe line during loading or unloading operations. Most of the companies have installed temperature and pressure gauges on the dock for the information of the man in charge of the shore connections, and as an added factor of safety against overloading the capacity of the hose and pipe lines.

On the unloading dock all the oil companies have now installed a tight section with a raised edge or rail six inches or more in height to catch any oil which may be spilled at the point where the unloading hose comes over the side of the vessel and connects with the shore pipe lines. In some cases this protection is constructed of tongued and grooved planks, while in other cases the protective area has been constructed of concrete. These protected sections of the dock often drain to a tank with a trapped outlet, in which any water falling on the dock may be separated and the oil collected. At one place in Rhode Island, where a 6,000-gallon slop tank is used, this tank has to be emptied at least every three months, the mixture removed being about two thirds oil.

All the oil-operating companies now have installed some kind of a drip pan or a sand box to catch the oil which runs out when the hose is disconnected. The advantage of a pan is that the oil may be saved, but it has the disadvantage that it may be overturned accidentally. Sand is preferable to sawdust if a box is used for the reason that, if the drip box happens to be overturned and its contents go overboard, the sand and oil mixture will go to the bottom, while the sawdust and oil mixture would float and become a nuisance. When not in use it is customary to cover the ends of the hose with a wood or metal cap held in place by bolts, thus permitting the hose to be hung on racks without danger of leakage of the oil which adhers to the inside.

Some of the oil and other oil products received, and a certain proportion of that sent out to foreign markets, is handled in barrels. The old wooden barrel used for oil is rapidly being replaced by reinforced steel drums. The danger from leaky barrels

FIG. 4. — UNLOADING OIL FROM TANKER.
Note the plugs in scupper holes, drip pan under hose ends, etc.

is therefore considerably reduced, although there is still the possibility that a barrel may be dropped from the sling as it is swung up over the side of the ship. As these barrels are often rolled for some distance over unprotected sections of the dock, supervision to ensure that they are tight and that they are not handled too roughly is necessary.

Prevention of Pollution from Handling of Oil on Land

The proper drainage of property on which any amount of oil is handled is a matter of considerable importance. Even when the utmost care is exercised, there will always be a certain amount of oil getting upon the ground from accidental spills and unavoidable leakage, and precautions must be taken to prevent this being flushed out into the public waters during heavy rainfall. Such a property at the shore line should always be protected by a raised embankment or a wall, and the general drainage of the section immediately on the shore should be away from the water front. At some oil plants the whole or part of the surface drainage is conducted to collecting ponds, from which the water will evaporate or leech into the ground. At other plants the surface drainage is conducted to separators. At the Standard Oil Company, where large volumes of water are needed for condensing in the refinery, much of the surface water is collected and stored for such use.

All waste waters of every kind from oil distillation and refining plants must be passed through a properly designed separator before being discharged. If elimination of all traces of oil from public waters is to be obtained, oil-carrying condenser waters from many steam power plants should also be passed through a separator, and in a few instances such separators have already been installed. We are also coming to the belief that a separator or something which will serve that purpose is needed near the outfall of all public sewers and of many surface drains to catch oil which may be spilled at inland points.

The separators constructed at different places vary considerably in design. The general principle of all is gravity separation in a series of compartments with over and under flow baffles, with some provision for removal of the oil collecting on the surface. The oil collected, together with more or less water, is usually pumped from the surface to a tall cylindrical tank, where it is heated for final separation of water from the recovered oil. Hand-operated skimming boards with long handles are often employed to push the oil on the surface forward to the suction of the skimming pump. In some separators the final effluent

is passed through a filter of some absorbent material to remove any semi-emulsified oil which will not separate by gravity. Sand has been used for filtration but coke or fine clinkers is better. Very good final filtration of oil wastes may be obtained by an excelsior mat. The filtering material acts solely as an absorptive medium and must be removed and replaced at regular intervals. For this reason it is better practice to have the filtering material

FIG. 5. — SEPARATOR AT OIL COMPANY PLANT TO REMOVE OIL FROM WASTE WATERS AND SURFACE DRAINAGE.

contained in small units in removable boxes or cages. Judging from my own observations excelsior is as effective in removing the last traces of finely divided oil as any inexpensive material, and has the advantage over sand or clinker in that it can readily be disposed of by burning. Coke which has been used for filtration may also be disposed of by burning, but special facilities for this have to be provided, as most plants where oil is handled in any quantity use oil-fired boilers exclusively.

To reduce the fire hazard storage tanks are usually either located in a pit or are surrounded by an embankment or wall to retain the oil in case of an accident or collapse of the tank. This protection also serves as a safeguard against oil pollution. Pipe lines running along the docks or on the water fronts, and sometimes the pipe lines running over or through the shore property, are usually carried in a box or in a cement-lined conduit. Ordinarily these pipe lines are paralleled by a steam line, as it is necessary to keep the heavy oils in a fluid condition. When these conduits are constructed of wood they are usually filled with sand, sawdust or some other absorptive and insulating material. When the conduits run through the ground they are usually pitched back to a pit or slop tank where any oil leakage may be collected and recovered. More or less water also finds its way back through the conduits into these drip boxes, which are usually provided with trapped outlets, and in a certain degree serve as separators.

The car-loading yards require considerable supervision if oil spills are to be prevented. It is not uncommon for one man to be loading two or three cars at a time, with the attendant possibility that one may overflow while he is attending to another. The tank cars themselves are used indiscriminately for whatever types of oil may be required for shipment at the time. If a car has been previously filled with crude oil or something of that nature, the drainage from the sides of the tank which has collected in the bottom must be removed before this car can properly be refilled with some refined product, as gasoline or lubricating oil. In the old days it was the usual practice to open the drainage cocks in the bottom and allow the oil sludge to run out upon the track and find its way wheresoever gravity took it. At the car-loading tracks of one company which I visited some years ago catch basins had been built between the rails, so spaced that all drainage from the cars, as well as surface water, could run directly into the harbor.

The Board insists that all direct drainage connections from car-loading yards into the harbor be removed or effectually sealed. Most of the oil companies now keep the surface of the ground in the loading yard well sanded to absorb minor drips and spills,

the oil-soaked sand being scraped off and carted away or used for surfacing walks and driveways. Instead of being discharged between the tracks or run into the harbor, the oil sludge and drainage from the tank cars are now discharged into cans or into suitable slop tanks placed beneath the tracks.

FIG. 6. — TANK CAR LOADING YARD ON THE WATERFRONT.

In general the conditions relating to the storage and handling of oil at places where oil is used for fuel do not differ materially from those at the shore plants of the oil companies. As the handling of oil is the main business of the oil company, and is only incidental to the business of those using oil for fuel, spills

due to carelessness of employees are much more likely to occur at the latter places. In any systematic effort to control oil pollution, the user of oil for fuel and other purposes must not be overlooked.

At all oil-burning plants drip pans should be provided to catch oil from any minor leaks. If these plants have drains connecting with the public sewers, provision should be made for immediately closing these drains in case there is an oil spill. When there is any amount of drainage water to be taken care of there should be a separator for regular use in addition to the drain plugs. At many oil-burning plants a supply of sand is kept ready for immediate use as a temporary dam in case of a spill and for soaking up any minor oil leakage. In our survey of oil-burning plants we are recommending the sand box as a safety factor in all cases where one has not already been installed.

All oil-carrying pipes in oil-burning plants should be so placed that they can be inspected for their entire length, and inspection for leakage should be made at least once a day. If these oil pipes are so located that any leakage therefrom will drain directly upon the floor of the engine room or boiler room the quick detection of a leak will be more likely to result. The placing of oil-carrying pipes underground or in an enclosed pipe gallery is not good practice. If the pipes must be placed underground they should be carried in a tight conduit, which should drain to an inspection pit. It is needless to say that all oil-storage tanks at industrial plants should be placed in a pit or be surrounded by a wall or embankment, as is the practice at the large oil companies. Surface water drains from such pits or enclosures should not discharge into any natural watercourse or into public sewers, unless a separator or other effective means is provided to hold back any oil which may be present.

In many cases oil plants, gas works, and oil-burning plants located immediately on the water front are built up quite largely on made land. At such places special precautions must be taken to prevent seepage of oil through the ground. When the plant is old, and has been constructed on made land containing much porous material, the prevention of pollution is sometimes considerable of a problem. At some of the gas plants it was the

practice until a few years ago to pond the water gas wastes and then fill over the deposits with cinders or other absorbent material. Material of this kind on the water front is a constant source of trouble by the gradual leeching out of oily waters. Various expedients have been used to prevent seepage. Most desirable is a tight sea wall at the dock line, and this has been the precaution taken at certain of the more recently constructed

FIG. 7. — OIL COMPANY PLANT, SHOWING BULKHEAD BUILT TO RETAIN OIL FROM SPILLS AND SURFACE WASH.

oil-handling plants. At one oil plant offensive seepage was eliminated by driving tight sheet piling across the line of drainage from a battery of old oil storage tanks. Sheet piling is also under consideration as a means of preventing seepage through an old stone dock at one of the gas companies. As a means of preventing seepage and surface wash getting into the harbor from their plant, one of the oil companies has constructed a tight bulkhead 800 feet long on the harbor line, with lateral bulkheads 200 feet long connecting each end with the shore. This is provided

with trapped sluiceways to permit tidal movement and still retain any oil which may find its way into the enclosed lagoon.

One possible cause of oil pollution which we have not as yet found any adequate means of preventing is that which may occur during transportation of oil by rail. As in many places the railroads run very close to the water front a train wreck which included tank cars might result in an oil spill which would cause much damage. A similar hazard exists also during transportation of oil by tank trucks on the public highways. A spill from an accident to a tank truck has been described elsewhere in this paper. In the latter case the volume of oil likely to be spilled at any one time and place would be relatively small, and in the majority of cases it would be possible to localize the spill and thus prevent excessive damage being caused.

Education an Important Factor in Preventing Oil Pollution

One of the most important factors in the effective control of oil pollution is the education of the men who are engaged in handling oil in what to do in case of emergency. As our inspector goes about among the oil company plants he is continually noting new kinks or precautionary measures which are being used and passing these along to the men at other places where similar measures might be useful. In our survey of oil-burning plants our engineers make it a practice not only to point out weak places in the oil-handling equipment but to instruct the men in charge in what to do in case an accident should happen.

We are also endeavoring to spread the knowledge of what to do in an emergency among city and town officials, particularly among those having charge of sewers and highways. A case of a local official permitting oil from a leaking tank truck to escape into the harbor when this could readily have been prevented has already been cited. The essential thing in all such cases is to localize the spill in a small area, where the oil can easily be cleaned up and removed. A temporary dam of sand or earth will often serve to prevent spilled oil from flowing into a water course, or into sewers or drains. If the oil has already entered a

stream or any body of water it can usually be prevented from spreading by a boom. A simple boom can be quickly constructed by nailing six or eight inch boards on slightly wider boards in the form of a T. Other available material may be used. Hinge joints between sections can be made with canvas, bagging, pieces of automobile inner tube, or other flexible material. The only essential is that the face of the boom be wide enough to prevent the oil being sucked under by the current of the stream, or thrown over by small waves.

An instance of knowing the right thing to do and doing it occurred recently at one of our large oil-burning plants on the water front. At this plant the oil from the main storage tanks is drawn through a heating tank which holds about 10,000 gallons. In some manner water found its way into this heater, causing foaming, and the water-oil mixture immediately put out the fires in the boiler room. As this was a public-service corporation supplying power for lighting and industrial purposes it was necessary that the plant be put into operation as soon as possible. The management therefore ordered that the oil in the heater be run out upon the ground in the yard, using a sand embankment to hold the large pool of oil thus formed. Unfortunately the yard was on filled land composed largely of cinders and while overflow into the harbor was prevented by the temporary dam the oil soon began to seep through the ground into the water under the dock. The further spread of this oil was effectually prevented, however, by stringing a boom across the openings in the face of the dock. The oil collecting beneath the dock was later skimmed off and not a drop of oil from this spill found its way out into the harbor.

At a conference with the Board recently the agent of one of the larger oil companies was asked why it was that the oil men themselves had not previously taken precautions to prevent oil being spilled into the public waters. His reply was brief and to the point: "Nobody ever told us not to."

It is required in Rhode Island that copies of the regulations relating to handling oil be posted in a conspicuous place at all docks and shore stations. Copies of these regulations on cloth and on cardboard are supplied by the Board, it being one of the

duties of our inspector to see that they are kept posted at points where all persons engaged in the handling of oil may readily see them. All of the oil companies have placed copies of these regulations in the hands of the captains of their tank vessels, and in practically all cases the regulations have been conspicuously posted on deck, where both officers and crew may become familiar with their requirements. Certain of the companies have also gone much further than the mere letter of the law and have issued notices to their employees that they would be discharged for violation of these regulations, in fact, men have been discharged in a number of cases for carelessness or open violation of these rules. A typical order issued by one oil company reads as follows:

NOTICE. — Discharging or spilling oil overboard and pumping out bilges inside of harbor limits is prohibited on all vessels of this company. Officers who fail to enforce this regulation will be dismissed. They are also subject to the penalty imposed by law.

It should be observed that this company's rule is made broadly applicable to all waters in which their vessels may operate. It may not be out of place to mention that the New England Oil Refining Company of Fall River, Mass., has adopted similar orders applicable to their oil-carrying vessels and also to their shore plant. It is evident that the oil companies are making an effort not only to co-operate with us in keeping oil out of the troubled waters of Rhode Island, but are voluntarily extending that effort to the waters of other states.

RULES AND REGULATIONS ESTABLISHED BY ORDER OF THE BOARD OF PURIFICATION OF WATERS TO PREVENT THE DISCHARGE OR ESCAPE OF ANY PETROLEUM, GASOLINE, KEROSENE, TAR, OIL, OR ANY PRODUCT OR MIXTURE THEREOF, INTO THE PUBLIC WATERS OF THE STATE OF RHODE ISLAND

1. As used in these rules and regulations and each of these rules and regulations the word "person" means and includes and shall be construed to mean and include every individual, firm, co-partnership, association, private corporation and municipal corporation, whether acting as principal, agent or servant, and whether acting personally or by agents or servants, and these rules and regulations shall apply to each and every such person.

2. No person shall discharge or cause, suffer or procure to be discharged, or cause or suffer to escape into any of the public waters of the state any petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof.

3. No person shall deposit, or cause, suffer or procure to be deposited any petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof in any place on the bank or shore of any of the navigable waters within the state or on the bank of or in any tributary of any such navigable waters, or on any wharf, dock, or pier in any such waters, where the same shall be likely to be washed into any of the public waters of the state, either by ordinary or high tides, or by storms or floods, or otherwise, or in any place where the same shall be likely to be discharged or to escape into any of said public waters.

4. No person shall pump or discharge or cause, suffer or procure to be pumped or discharged into any harbor, river, bay, or inland waters of the state any bilge water from any ship, barge, tanker, boat or vessel which has been or is being used to convey as its principal cargo any petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof, or from any ship, barge, tanker, boat or vessel whereby any petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof shall be liable to be discharged or to escape into any of the public waters of the state.

5. No person shall scrape, wash, scrub, scour or swab, or cause, suffer or procure to be scraped, washed, scrubbed, scoured or swabbed, any part of any ship, barge, tanker, boat or vessel, or any tank or receptacle thereon, while such ship, barge, tanker, boat or vessel is in any harbor, river, bay or inland waters of the state or on any shore thereof or in any dry dock within the state, or any tank or receptacle in any place, whereby any petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof shall be liable to be discharged or to escape into any of the public waters of the state.

6. Every person shall post and keep posted a copy of these rules and regulations, typewritten or printed in type not smaller than pica in a conspicuous place, where the same may be easily read, at each of the wharves, docks and piers owned, leased, operated or controlled by such person, and at each entrance to each separate parcel of land owned or leased by such person which borders on, or any part of which is within one hundred feet of, any of the navigable waters within the state or any tributary thereof, and whereon there is deposited or stored at any one time any petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof, in greater quantity than twenty-one thousand gallons.

7. These rules and regulations shall not apply to the sewage of the city of Newport and town of Jamestown discharged into the waters of the state through their respective sewer outlets.

8. These rules and regulations shall be in full force and effect on and after the 19th day of November, A.D. 1920.

Any violation of the order establishing the above Rules and Regulations is punishable by a fine of not more than five hundred dollars or by imprisonment for not more than one year, or by both such fine and imprisonment.

ABSTRACTS FROM CHAPTER 125, GENERAL LAWS OF RHODE ISLAND, CONCERNING THE POLLUTION OF PUBLIC WATERS

As used in this act the following terms shall, where the context permits, be construed as follows:

The term "sewage" shall be held to mean and to include any human or animal excremental liquid or substance, any decomposed animal or vegetable matter, garbage, offal, filth, waste, chemicals, acid, dye-stuff, starch, coloring matter, oil and tar, and any compound, solution, mixture or product thereof, and every substance which may be injurious to public health or comfort, or which would injuriously affect the natural and healthy propagation, growth, or development of any fish or shell-fish in the waters of this state, or of the nourishment of the same, or which would injuriously affect the flavor, taste, or value as food of any such fish or shell-fish; or which would injure or defile any vessel, boat, wharf, pier, or any public or private property upon, in or under said waters, or any shore thereof.

The term "waters" shall include all tide-waters within the state and all inland waters of any river, stream, brook, pond or lake.

The term "person" shall include an individual, firm or copartnership, and association, and a private or municipal corporation.

The term "pollution" shall be held to mean the entrance or discharge of sewage into any of the waters of the state in such quantity as to cause or be likely to cause, either by itself or in connection with other sewage so discharged, damage to the public, or to any person having a right to use said waters for boating, fishing or other purposes, or owning property in, under or bordering upon the same. (Sec. 1.)

If the board shall have reasonable cause to believe that any person is polluting the waters of the state, or if complaint shall be made to it that such is the fact, it shall be the duty of the board to investigate such matter. (Sec. 4.)

If any person is polluting the waters of the state, and if after such investigation the board shall so find, it shall make its findings in writing to that effect and may enter an order directing such person to adopt or use or to operate properly, as the case may be, some practicable and reasonably available system or means to prevent such pollution, having due regard for the rights and interests of all persons concerned. Such order may specify the particular system or means to be adopted, used or operated: *Provided, however*, that where there is more than one such practicable and reasonably available system or means, such order shall give to the person complained of the right to adopt or use such one of said systems or means as he may choose. Such order shall specify the time within which such system or means shall be adopted or used or such operation thereof shall be commenced. Such time may be extended by the board in its discretion. (Sec. 5.)

Any person who shall adopt or use and shall properly operate a system or means to prevent the pollution of the waters of the state with the approval

or in compliance with an order of the board shall thenceforth, as long as such approval or order remains unrevoked and unmodified, be deemed to have complied with all orders of the board issued during such period under the authority conferred upon it by section 5 hereof. (Sec. 6.)

The board shall have full power to inspect, and make orders regulating and directing all methods, means and devices employed on any steamer or other vessel in the public waters of the state, in receiving, carrying or discharging any petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof; and the board may by order establish all rules and regulations to prevent the discharge or escape of any of said substances into the public waters. (Sec. 8.)

Any person aggrieved by any order of the board directing such person to adopt or use or operate a system or means to prevent pollution, or modifying or revoking any such order, or dismissing any complaint or application, or finding that such person has been guilty of pollution in violation of an order of the board, may appeal to the supreme court for a reversal thereof on the ground that the same is unlawful or unreasonable. (Sec. 12.)

No person shall be held to have violated the provisions of this act where the sole damage caused by him is the rendering unsuitable for drinking purposes or ice supply of the waters polluted by him. (Sec. 16.)

Discussion

JOHN P. WENTWORTH:* I am sure we have all enjoyed Mr. Gage's talk very much and appreciate his coming here this evening. I feel sure he will be very glad to answer any questions any one may care to ask.

ALMON L. FALES:† Mr. Chairman, the hour is late and I haven't much worth adding, but should like to say a few words. I suppose there is no place in the country where so much has been done to control oil pollution as in Narragansett Bay, and I am sure great credit is due the Board of Purification of Waters, and particularly Mr. Gage, for the results accomplished.

Oil pollution is a very serious matter in a number of aspects. Mr. Gage has alluded to the fire hazard, which is a very important consideration. Oil pollution is also very objectionable from the æsthetic and sanitary points of view, particularly with respect to boating and bathing. Furthermore, it affects the use of water, not only for industrial purposes but also for domestic consumption.

* Chairman, Sanitary Section, B. S. C. E.

† Of Metcalf & Eddy, Consulting Engineers, Boston.

Oil pollution of navigable waters in the United States has caused several bills to be introduced in Congress to eliminate the trouble. Last year a resolution was passed requesting the President to call a conference of maritime nations looking to the adoption of effective means of controlling oil pollution of navigable waters. Great Britain has passed very drastic laws relating to oil pollution, and similar legislation is now pending in Congress.

The American Water Works Association's Committee on Industrial Wastes in Relation to Water Supply found that a considerable number of water supplies have been affected by wastes from oil refineries, the principal trouble being the tastes and odors imparted to the water, which are not removed by the ordinary water purification processes including coagulation and filtration. Aeration of the water has been found beneficial but this has not proven to be a complete remedy in all cases.

The discharge of oil from garages and other establishments into sewers has caused considerable trouble at some sewage treatment plants. The skimming of the oil from sedimentation tanks is an expensive and not altogether efficient method of removal. If the oil goes on to filters, it is likely to render them ineffective. In recent designs for certain sewage treatment plants provision has been made for the removal of the oil as a preliminary treatment.

Recently there was a case where water used for bleaching cotton goods contained oil at times which did a great deal of damage to the goods. In this case a cylindrical tank was designed in such a way as to introduce the water tangentially near the bottom, thereby giving it a whirling motion and bringing the oil to the top, where it could be skimmed off, the effluent being drawn off below the surface on the same side as the inlet, but with a baffle between. A somewhat similar method has been used for removal of floating matters from sewage.

It is a very difficult problem to prevent oil pollution, and I am sure that what Mr. Gage has told us tonight has been not only of interest but instructive as well.

EDWARD WRIGHT:* I would like to compliment Mr. Gage on his instructive paper. On two or three occasions I have been

* Assistant Engineer, Massachusetts Department of Public Health.

down through Narragansett Bay and have seen the fine results of his work and the work of his Board; in fact, conditions down there are nearly as good as in Fall River harbor!

I would like to add one other thing to what Mr. Fales has said. He spoke about legislation on oil pollution before Congress. There are at present five or six bills before Congress for preventing oil pollution. Several very extensive hearings have been held, and the big question at present seems to be as to whether the final bill should include land plants, such as gas works, oil refineries, etc. The committee's report is held up pending certain investigations by the Bureau of Mines, and hearings will be continued a little later on. It might be valuable in this connection if this Section went on record in favor of nation-wide legislation regarding oil pollution.

ROBERT S. WESTON:* I can't tell you how much I have enjoyed this paper. It has been so very clear, and knowing something about the subject, I realize how well Mr. Gage has brought out the essential points.

One thing is worth mentioning, that is, the difficulty of separating oil and water from refinery waste. One usually thinks of oil and water as readily separating into two layers, the oil on top and the water beneath; but in an oil refinery they have many processes which emulsify the oil. They treat it with acid and then with soda and water, — agitate it, — do all sorts of things. The product of the sewers discharging into the separator is usually turbid and the oil is separated with a great deal of difficulty. This difficulty is greatly enhanced when the refinery doesn't stop distillation at the asphalt stage but carries it to coke. Then powdered coke is discharged into the separator. This is a nasty mess. It can't be called anything else. In the mixed waste there seem to be bubbles of oil, each surrounded with a film of powdered coke and the combination suspended in water. Some of these aggregates have just enough of a load of coke to give them about the same specific gravity as water. Some have a greater specific gravity and sink to the bottom. Those that sink to the bottom seem to lose their load of coke gradually, the oil rising to the top while the coke stays on the bottom. It is

* Of Weston & Sampson, Consulting Engineers, Boston.

extremely difficult to separate the oil and coke from the water except by filters of coke or excelsior.

When a ship is unloading oil at a refinery great difficulty exists in maintaining a proper system of signals between the people on the shore who are watching the filling of the tanks and those on the ship, at the end of a long wharf, who are pumping it ashore. When the tanks are full the operators have to look out for closed valves with the pumps operating at high pressure against them, and difficulties of that order. Failures here cause disastrous "spills."

Mr. Gage has spoken about difficulties with flexible hose connections. One company with which we have been connected for some time has overcome this by the use of pipe with hinged metal joints and a rather elaborate hoisting apparatus for handling such heavy devices.

The whole problem has come to New England within a few years. Farther south pollution has existed for some time. In New England the nuisance has been fought with vigor, largely because of the attractiveness of our coastal waters for recreation. The resistance against the oil-pollution nuisance is growing, and the inevitable result of the agitation will be the passage of laws and regulations to protect against spoliation such a valuable asset as our navigable waters.

HARRISON P. EDDY, Jr.:* We have had occasion to consider the effect of road oil that washed off in time of storm into small streams that were used for bleaching purposes. We have noticed that at comparatively low temperatures during a spring thaw very substantial films of oil would run down the gutters of oiled streets. There are bleacheries which now have considerable trouble after storms from that very thing. I don't see how you can stop that sort of trouble except by the mills taking the oil out before they use the water. You can't stop it at the source.

ARTHUR L. GAMMAGE:† One point might be brought out and that is that the amount of oil in these emulsions is very small. There might be, for instance, 27,000 p.p.m. of total solids and perhaps 13,000 p.p.m. of chlorine and 1,000 to 1,100

* With Metcalf & Eddy, Consulting Engineers, Boston.
† Chemist, Weston & Sampson, Consulting Engineers, Boston.

p.p.m. of sulphates, and still there might be only 10 to 20 p.p.m. of oil residue. But this mixture might be emulsified and cause a lot of trouble, even with this small amount of oil.

GORDON M. FAIR:* Mr. Fales has mentioned the effect of oil on sewage purification. This reminds me of a visit I made to the Davyhulme plant at Manchester, England, where the activated sludge process was in use. The tanks were out of commission at the time of my visit because of a large discharge of oil received the day before from the sewerage system. This oil prevents absorption of oxygen at the surface, and films of oil will form around the air bubbles and prevent the escape of the oxygen from them to the sewage.

The same thing occurred at Sheffield, where they have the mechanical method of agitation. The only time that Sheffield experienced difficulty with the activated sludge method was when a charge of oil was received through the sewers which put their tanks out of operation. Aeration takes place at the surface, and oil floating on the surface prevents absorption of oxygen. I should think oil might be quite a factor also in harbor troubles by preventing reaeration of the water.

MR. WESTON: I wonder whether Mr. Fair knows that Professor Gorham of Brown University has made experiments on the effect of oil on the absorption of oxygen by water. He says that water beneath a film of oil absorbs oxygen faster than water exposed to air. Professor Gorham's experiments probably refer to still water. It may also be true that water stilled by oil will be agitated by the wind enough less readily to overcome the greater rate of absorption induced by the film of oil.

MR. FAIR: I know that Mr. M. C. Whipple when he wants to keep a sample of water away from the air puts a heavy film of oil over it, and I have noticed that it will keep at very low oxygen content in spite of or rather as a result of the action of the film of oil.

MR. WESTON: I would like to ask Mr. Gage what his opinion is of that theory; if he knows more than the mere statement of Professor Gorham about it?

MR. GAGE: I really don't know anything about it except

* Harvard Engineering School, Cambridge, Mass.

that Professor Gorham testified to that effect in a suit for damages brought against one of the oil companies by a certain oyster grower. I do know, however, that absorption of atmospheric oxygen into the water at the surface is greatly increased by rippling of the water through action of the winds, and of course we all know that the effect of oil is to make a slick surface without ripples. Without good evidence to the contrary we must assume, therefore, that a film of oil on the surface will cut down the rate of reoxidation of the water, and if the oxygen content of that water had been quite largely depleted, this would prolong the effect of other types of pollution.

One point brought out by Mr. Weston is the recent agitation against the increasing oil pollution. Perhaps some of you may not know that there has been formed within the last two years a national association for prevention of pollution of coastal waters by oil. This association is made up of representatives of coastal communities, state organizations, a few engineering organizations, and of the chambers of commerce of many cities which are affected by oil pollution. It is quite active, has a meeting each year for paper and discussion, and is appearing before the Congressional Committees in relation to national legislation for control of such pollution.

In attempting to keep my remarks within a reasonable time limit I mentioned only briefly that the oil used in anti-mosquito work was one of the sources of oil pollution. We have had some instances where oil used in this way has been washed down the streams by heavy rainfall. This brings up the question whether we would rather have the oil or have the mosquitoes. The people down the Bay have their own mosquito problem — a different proposition from the inland one — and they can't see why they should be bothered with oil from the inland marshes. Speaking of the damage caused by oil, the opinion of most biologists is that oil is very detrimental to the development of shellfish and also of some of the fin fish. Oysters, clams, quahogs and similar shellfish all go through a free-swimming stage between the time they hatch and the time they set and form a shell. At this time the spat are found in large numbers at the surface and are readily destroyed if they come in contact with oil. The eggs of certain

fin fish also float at the surface and would be destroyed by oil. Another way in which oil is detrimental to fish life is through the destruction of the smaller types of animal and vegetable life which directly or indirectly furnish the food supply for both fin fish and shellfish. The effect of floating oil on shellfish growing in deep water is practically nil. In a suit for damages brought by certain Rhode Island oysters growers against one of the oil companies, the defendants offered as evidence sections of a pile from their dock upon which oysters from two or three months old to three or four years old were growing in a healthy condition. Sections of this pile above waterline were covered with oil and the records showed that there had been a number of oil spills at this point within the life of these oysters. This was sufficient to convince the jury that adult oysters were not being destroyed by oil pollution. It has also been claimed that clams which grow above low tide are destroyed by oil, but I have seen apparently perfectly healthy clams growing in sand where you had to dig through an inch of oil to get to the sand. The wastes from gas works, which we classify with oil pollution, are another story. Some of these wastes are heavier than water and might readily affect shellfish growing on the bottom. The food value of both shellfish and fin fish is also affected by oil pollution as well as by gas house wastes. As Mr. Gammage has stated, the waste waters from oil refining usually contain some emulsified oil, and while the amount of this oil may be extremely small, it is sufficient to impart a kerosene flavor to fish and shellfish which makes them very unpalatable.

MEMOIR OF DECEASED MEMBER

RANSOM ROWE*

Ransom Rowe was born in Huntington, Quebec, in 1865 and moved to Burlington, Vermont, at an early age.

He received his education in the schools of Burlington. After leaving school he worked for a contractor where he learned the bricklaying trade. When he went away to the Spanish war he was an inspector of masonry.

He came to Boston in 1894, and after working for contracting firms here he determined to become a contractor himself. He started in business with very little capital, backed only by his own ability. His work was his best advertisement, and gradually he began to succeed as people acquired confidence in his ability.

Mr. Rowe became one of the most successful contractors in the vicinity. Many miles of boulevards have been constructed by the Rowe Contracting Company, and he had quarries in Malden and West Roxbury whose output of crushed stone was one of the largest in New England.

Besides being a member of the Boston Society of Civil Engineers, he was a prominent member of the Massachusetts Highway Association, President of the New England Road Builders Association, a trustee of the Brighton Post of the American Legion, a Spanish War Veteran and a member of the Boston Athletic Association.

Ransom Rowe was honest and upright and always true to his word, and was honored and respected by all who knew him. His death occurred unexpectedly on April first.

Mr. Rowe is survived by his widow and two sons.

* Memoir prepared by George E. Stuart and Joseph A. Tomasello.

Vol. XI JUNE, 1924 No. 6

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PROCEEDINGS

MINUTES OF MEETINGS

Boston Society of Civil Engineers

Boston, May 21, 1924. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, Tremont Temple, and was called to order by the President, Edwin H. Rogers, at 7.15 P.M. There were about 200 members and guests present.

The minutes of the previous meeting were approved as published in the April JOURNAL.

The Secretary announced the names of those elected to membership by the Board of Government at meetings held on April 24, 1924, and on May 21, 1924.

April 24, 1924. — *Members:* Elbridge R. Conant, Herman Fay, Francis T. Flynn.*

Juniors: Vernald W. Fox, James E. Jagger, Clyde C. Willey.

May 21, 1924. — *Members:* J. Frank Delaney, Chester J. Ginder*, Everett N. Hutchins, J. Donald Mitsch.

Associate: Henry I. Harriman.

Juniors: Francis B. Quinn, Walter L. Thompson, Julius Waldman.

The President announced the death on April 1, 1924, of Ransom J. Rowe, a member of the Society. He stated that a committee would be appointed to prepare a memoir.

The President reported a recommendation from the Board of Government that the June meeting of the Society be omitted

* Transferred from Grade of Junior.

on account of the inspection trip to the new Edison Steam Power Station at Weymouth and the Airplane Carrier "U. S. S. Lexington" under construction at the Fore River Ship Yard, arrangements for which were being made by the Social Activities Committee. It was voted to omit the June meeting.

It was announced that the American Society for Municipal Improvements was to hold its annual convention in Boston in the latter part of September, 1924. Since it was possible that arrangements might be made to hold a joint meeting of the American Society for Municipal Improvements and the Boston Society of Civil Engineers it was voted that the Board of Government be authorized to postpone the regular meeting of the Society in September until the end of that month, in order to arrange a joint meeting with the American Society for Municipal Improvements if it appeared desirable.

After the conclusion of the business of the meeting, the President introduced Mr. Albert A. Northrop of Stone & Webster, Inc., who presented two films of engineering projects. The first one was the "Construction of the Gilboa Dam and the Shandaken Tunnel." This showed in detail the construction features of these jobs, both of which were a part of the new water supply of New York. This film was made through the courtesy of the Board of Water Supply of the City of New York.

The next film was of the "Construction of the 60,000 H.P. Caribou Hydro-Electric Development in the Sierra Nevada Mountains of California." This plant of the Great Western Power Company is the second of seven plants in the development of 640,000 H.P. on the Feather River. This film showed the work from the early stages of the surveys through to the formal opening of the plant for the production of power.

The next film, furnished by Patrick McGovern, Inc., of New York, showed the "Casting and Driving of Reinforced Concrete Piles for the Jamaica Bay Causeway at Far Rockaway, N. Y."

The program for the evening concluded with the showing of this film. From the size and interest of the audience it appeared that a "movie" evening of this kind each season meets with the approval of the members.

Adjourned about 9 P.M.

J. B. BABCOCK, *Secretary.*

Designers Section

Boston, May 14, 1924. — The regular meeting of the Designers Section of the Boston Society of Civil Engineers was called to order by the Chairman, Edward H. Cameron, in Chipman Hall, Tremont Temple, at 6.05 P.M.

The report of the April meeting was read and approved.

The Chairman introduced Major Stuart C. Godfrey, Engineer Officer, First Corps Area, who gave a talk on "Muscle Shoals," with particular reference to the Wilson Dam.

Major Godfrey illustrated his talk with lantern slides showing different stages of work on the Wilson dam.

After the talk the meeting was opened to questions and discussion.

There were 113 members and visitors present.

The meeting was adjourned at 7.20 P.M.

Waldo F. Pike, *Clerk.*

Highway Section

Boston, May 28, 1924. — A meeting of the Highway Section was called at 8 o'clock, the Chairman, Mr. A. W. Dean, presiding.

The records of the previous meeting were read and approved.

The first speaker of the evening was Mr. Samuel Hobbs, of the Portland Cement Association. Mr. Hobbs gave an interesting and instructive talk on the subject of cement concrete road construction, and concluded with a moving picture of a cement concrete road under construction where up-to-date and modern equipment was used.

The next speaker was Mr. Prevost Hubbard, Chemical Engineer of the Asphalt Association. Mr. Hubbard spoke on the subject of asphalt and its uses in road construction, covering the production, treatment and the finished product. He illustrated his talk with lantern slides.

The last speaker of the evening was Mr. John S. Crandell of the Barrett Company. Mr. Crandell gave an interesting illustrated talk on the subject of tar and its various uses in road construction.

A rising vote of thanks was given the speakers of the evening for their interesting and instructive talks.

There were 24 present.

Adjourned at 10.55.

A. B. APPLETON, *Clerk.*

APPLICATIONS FOR MEMBERSHIP

[June 15, 1924.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission

FELDERMAN, HYMAN, Boston, Mass. (Age 25, b. Bucharest, Roumania.) Graduate of Providence Technical High School in 1917, and of Lowell Institute, building course, in 1922. Experience: 1917–22 structural iron shop work and temporary drafting with an architect and at Watertown Arsenal; at present drafting and designing with Silverman, Brown & Heenan, Architects, Cornhill, Boston. Refers to H. F. Bryant, W. A. Bryant, W. W. Clifford, Dean Peabody, Jr.

LASSITER, RICHARD THORNTON, New York, N. Y. (Age 22, b. Holyoke, Mass.) Graduate of M. I. T., 1924. Refers to J. B. Babcock, H. K. Barrows, C. B. Breed, J. W. Howard, C. M. Spofford.

MacDonald, Edmund John, Newtonville, Mass. (Age 24, b. Cambridge, Mass.) Graduate of Massachusetts Institute of Technology, 1921. From 1922–24 employed as a mining engineer by Carnegie Coal Company, and at present by John MacDonald Construction Company. Refers to J. B. Babcock, Scott Keith, C. M. Spofford, Hale Sutherland.

For Transfer

Gillett, Laurence Arnold, St. Augustine, Fla. (Age 27, b. Newburyport, Mass.) Graduate of Massachusetts Institute of Technology, 1919, in sanitary engineering, and of Lawrence Scientific School. Experience as follows: August, 1918–January, 1919, in U. S. Army; January, 1919–June, 1919, rodman; June, 1919–October, 1919, with Illinois State Highway Commission on reinforced concrete and steel design; October, 1919–November, 1920, as purchasing field office manager at Brockton and Fall River; December, 1920–January, 1923, with Massachusetts State Department of Public Health; January, 1923–July, 1923, on water supply investigation; and July, 1923, to date, with Florida East Coast Railroad, assistant engineer, structural department, design and construction of bridges, etc. Refers to C. B. Breed, F. H. Horton, A. D. Weston, R. S. Weston, Edward Wright.

LIST OF MEMBERS

Additions

Jagger, James E.	M. I. T. Dorms., Cambridge, Mass.
Johnson, Willard H.	11 Fairmount St., Medford Hillside, Mass.
Thompson, Walter L.	888 Mass. Ave., Cambridge, Mass.

Changes of Address

Babcock, Paul A.	1807 East Broadway, Toledo, Ohio.
Berry, Charles R.	101 Tremont St., Boston, Mass.
Brennan, Fred S.	12 Landon Circle, Lynn, Mass.
Brown, Oliver B.	10 Trull St., Dorchester, Mass.
Fox, Walter S.	101 Milk St., Room 804, Boston, Mass.
Gammage, Arthur L.	Robinson & Co., 10 Tremont St., Boston, Mass.
Houser, George C.	Peach's Point, Marblehead, Mass.
Jackson, Dugald C.	31 St. James Ave., Boston, Mass.
Knowlton, Willis T.	502 Hosfield Bldg., Los Angeles, Calif.
Lessard, Theodore T.	168 Mass. Ave., Springfield, Mass.
Longfellow, George P.	c/o E. H. Friedrich Co., Holyoke, Mass.
Manley, Henry	20 East 53d St., New York, N. Y.
Mirick, George L.	4245 Rose Hill Ave., Cincinnati, Ohio.
Moreland, Edward L.	31 St. James Ave., Boston, Mass.

PARSONS, ALFRED D.	315 Pearl St., Room 745, Hartford, Conn.
PARSONS, WILLIAM N.	19 Hammond St., Waltham, Mass.
ROBBINS, HENRY C.	Densmore & LeClear, 31 St. James Ave., Boston, Mass.
ST. AMAND, LOUIS J.	14 Beacon St., Boston, Mass.
SMITH, MERRITT P.	43 Hamilton St., Medford Hillside, Mass.
SPALDING, FREDERIC P.	1016 Middlesex St., Lowell, Mass.
STALBIRD, JAMES A.	c/o N. J. D. W. S. Comm., Wanaque, N. J.
SWEET, FRANK A.	193 Central Ave., Pawtucket, R. I.
THORON, BENJAMIN W.	R. F. D. 1, Upper Marlboro, Maryland.
TRAVERS, J. FRANCIS, Jr.	1775 Mass. Ave., Cambridge, Mass.
VAN DER PYL, EDWARD	Pres. & Treas., Aerobelle Co., 316 Shrewsbury St., Worcester, Mass.
VARNEY, HENRY A.	Room 25, Town Hall, Brookline, Mass.
WADE, CLIFFORD L.	1646 Liholiho St., Honolulu, H. I.
WRIGHT, FRANK V.	French & Hubbard, 210 South St., Boston, Mass.

DEATH

CORTHELL, ARTHUR B.	May 24, 1924

LIBRARY NOTES

BOOK REVIEWS

"THE CONSTRUCTION OF ROADS AND PAVEMENTS," by Thomas R. Agg, Professor of Highway Engineering, Iowa State College. Third Edition. Revised and enlarged. McGraw-Hill Book Company, Inc., New York. 500 pp.

REVIEWED BY JOHN B. BABCOCK*

"The Construction of Roads and Pavements," by Professor Thomas R. Agg, is now presented in its third edition. This treatise was first published in 1916, and the author has thoroughly revised it at intervals of about four years each. Developments in highway engineering have been so rapid during the past few years that constant revisions in books on this subject are necessary. It is not essential to present each new method which is put in practice, but it is important to cover those new developments which have made basic changes in the science of highway engineering. The author has succeeded in incorporating many

* Assistant Professor of Railway Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

new features in this edition without increasing the volume by more than fifty pages. This has been done by condensing the material dealing with those parts of the subject whose importance has become relatively less.

The more important changes are those dealing with the Design of Rural Highways, Portland Cement Concrete Roads and Economic Comparisons of Roadway Surfaces. The chapters on these subjects have been almost completely rewritten. The last chapter on Road Material Testing, which has been rearranged to some extent, includes the methods of testing recommended by the Committee on Tests and Investigations of the American Association of State Highway Officials.

An entirely new feature in this edition is the set of Suggested Class Problems at the end of many of the chapters.

In the Design of Rural Highways, Professor Agg now includes considerable material on tractive resistance of roadways and the effect of grades and of rise and fall on vehicular traffic. Superelevation and the widening of curves have also been treated thoroughly.

A number of pages on the theory of design of Portland Cement Concrete Roads and Pavements provides a distinct addition to this chapter. The author devotes considerable space to the methods devised by Clifford Older and to comparative designs for different types of roadway.

One of the most important revisions in this new edition is that dealing with the Economic Considerations involved in the Comparison of Roadway Surfaces. Professor Agg has included material on road costs, economic life, maintenance costs, operating costs, traffic analysis and the many other features which have become important with the great increase in motor traffic and the consequent increase in the construction of the more permanent types of pavement.

The foregoing has dealt entirely with the changes involved in the new edition. For those not already familiar with this book it may be of interest to review briefly its general scope. "The Construction of Roads and Pavements," while originally written as a textbook for use in colleges, includes much data of value to the practicing engineer. After a general discussion of

highway systems, surveys for road improvements, drainage and control of erosion and the design of rural highways, the author takes up in detail the important types of roads: earth, sand-clay, gravel, water-bound macadam, Portland cement concrete, vitrified brick, wood-block, stone-block, bituminous materials, dust layers and bituminous carpets, penetration and mixed macadam, and sheet asphalt and asphaltic concrete.

The final chapters are devoted to economic comparisons of roadway surfaces, selection of type of surfaces, design of municipal pavements, maintenance and road material testing. A glossary of terms employed in highway engineering defined by a special committee of the American Society of Civil Engineers or by the American Society of Testing Materials is included at the end of the book.

The serviceableness of a book for use as a text depends on two things — the value of the material and the method of presentation. The writer believes that Professor Agg has succeeded in choosing satisfactorily the material to be included in this present edition. The method of presentation is admirable from the standpoint of teaching. It is well arranged, properly headed and subheaded, and the reader can find what he wishes without difficulty. In any book, some mechanical faults are sure to appear, and in this instance a minor criticism might be offered with respect to the Table of Contents, which appears not to have been carefully revised, in some instances, to agree with the text of the new edition.

"Plan Reading and Quantity Surveying," 200 pp., and "Estimating Building Costs," 240 pp., by Charles F. Dingman. McGraw-Hill Book Company, Inc., New York.

Reviewed by Walter W. Clifford*

Probably no branch of construction work is subject to more pet methods of men who have little use for the other fellow's methods than is the case with estimating. It follows that few estimators have ever found any satisfactory book on the subject. They can undoubtedly find fault with these volumes, which

* Of Clifford & Roeblad, Consulting Engineers, 101 Tremont Street, Boston.

are, however, written primarily for the student of the subject. But as one can usually benefit by another's ideas, whether he agrees with them or not, the experienced estimator can undoubtedly benefit from these also.

The physical makeup of these books should aid in their popularity, for while neither of the popular phrases "Handbook" or "Pocket Book" is used in their titles, both volumes can conveniently be slipped into a coat pocket. Aside from convenience in carrying and handling, their brevity has the great advantage that all the essential principles are clearly stated without being buried in the mass of detailed data so discouraging to the novice. In fact, the general treatment is that of the textbook, emphasizing method rather than fact.

The volume on Quantity Surveying has, beside an introductory chapter and one on plan reading, chapters on all the major parts of a building contract, explaining methods of taking off quantities on the various classes of work. It also has a brief bibliography and a reminder list. Mr. Dingman's advice to use feet and inches rather than decimals in computations will undoubtedly sound strange to many, but as a whole the purpose as stated in the preface — "to delineate the methods to be used in scaling quantities from plans of projected buildings and setting those quantities down" — is admirably carried out.

The volume on Estimating Building Costs continues to emphasize method although unit time for various operations is given for the major items. The book is divided into chapters corresponding to the chapters of the ordinary specification. While Mr. Dingman cautions the reader to use proper local prices for labor, it would seem advisable in these times also to make careful comparison of the quantities which the various classes of labor do produce in any locality with those which he says they can do. This volume also contains a chapter on Short Cut Methods of Estimating by the method devised by Mr. Chas. T. Main, Member of the Boston Society of Civil Engineers.

On the whole, the methods suggested by Mr. Dingman represent good practice in building work, and the books should be of especial value to the student and the younger estimator.

Because of their convenient size and arrangement, and the accessibility of their data, they should be useful reference reminders to the experienced estimator as well.

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U. S. Government Reports

Manual of Bureau of Yards and Docks. Navy Dept.

Port of New Orleans, La. Bureau of Research, U. S. Shipping Board.

Report of Chief of Weather Bureau 1922–23.

Municipal Reports

Holyoke, Mass. Annual Report of Board of Water Commissioners 1923.

New Bedford, Mass. Annual Report of Water Board. 1923.

North Adams, Mass. Annual Report of City Government. 1923.

Springfield, Mass. Annual Report of Municipal Water Works. 1923.

Miscellaneous

Hydraulic Flow Reviewed. A. A. Barnes.

Research Narratives. Collected by Engineering Council.

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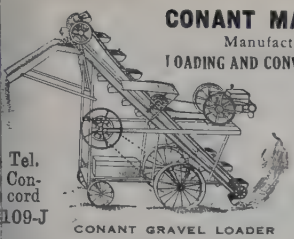

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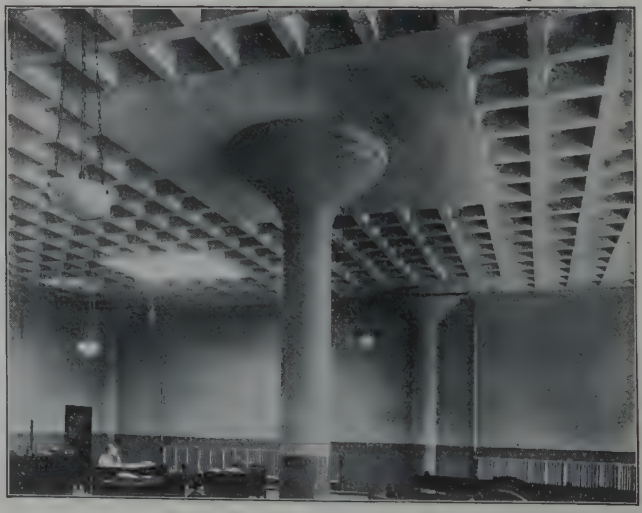

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